No. 8. Vol. IX. August, 1916.

The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by

LEON GASTER

10/6 Yearly. THE JOURNAL OF SCIENTIFIC ILLUMINATION. *1/- a Copy.*

OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London 1909.)

Among other articles this number contains :—

Notes on the Use of Electric Incandescent Lamps.

Radium and other Luminous Compounds.

A Year's Progress in Illuminating Engineering (concluded).

Co-operation between the Gas Company and the Architect.

The Photometry of Gas-filled Lamps.

Other matters dealt with include :—

REVIEWS OF BOOKS—LIGHTING OF ARMY HUTS—THE PROJECTING LANTERN—A CASE OF INDUSTRIAL INDIRECT LIGHTING, &c.

ILLUMINATING ENGINEERING PUBLISHING COMPANY, LTD.,
32, VICTORIA STREET, LONDON, S.W.
(TEL. NO. VICTORIA 5215.)

THE GAS LIGHT AND COKE COMPANY

will be happy at any time to co-operate fully with any Member of the Illuminating Engineering Society in the planning of the lighting of any room or building situated within their area of supply, and in making any experiments in connection therewith to the end of ensuring its illumination on scientific and practical lines.

Communications addressed to the Chief Office, Horseferry Road, Westminster, S.W., and mentioning "*The Illuminating Engineer*," will receive special attention.

The
ILLUMINATING
ENGINEER
Edited by
LEON GASTER
ELECTRICITY · ACETYLENE · OIL · GAS

THE JOURNAL OF SCIENTIFIC
ILLUMINATION.
OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London, 1909.)

ILLUMINATING ENGINEERING PUBLISHING COMPANY LTD
32. VICTORIA STREET, LONDON S.W.
Tel. No. 5215 Victoria.

EDITORIAL.

Concerted Effort in the Lighting Industry.

The steady tendency towards co-operation between different sections of the lighting industry is illustrated by several discussions that have taken place in the technical press during the past month. The Report issued by the Committee of the Institution of Electrical Engineers formed to prepare a programme to be submitted to the projected Board of Trade Committee on the Electrical Trades has naturally been the subject of comment, and in the gas journals the desirability of an analogous inquiry into some of the points raised in connection with the gas industry is suggested.

Again one of our electrical contemporaries, in pointing out the need for co-operative publicity, refers to the campaign so successfully undertaken for gas by the British Commercial Gas Association, and urges the need for a similar effort in furthering electric lighting. Thus each camp is on the alert to scrutinise and learn from the efforts of the other and to make good any omissions thus revealed in their own organisation.

At the present moment uniformity of policy is the more desirable in view of the problem of economising in coal supplies. If full advantage were taken of the resources of illuminating engineering, *i.e.*, if properly designed reflectors and modern lamps and burners were judiciously used, an economy of 10 per cent. in the lighting bills throughout the country could easily be made. The saving in coal from this source would probably amount to hundreds of thousands of tons. Gas and electric

supply companies should, however, adopt a common policy in approaching the consumer utilising existing avenues of publicity and creating new machinery such as would be of great value after the war. No doubt a thoroughly efficient co-operative scheme of publicity in connection with electric lighting might be useful in this direction, and in normal times it would also be of permanent value to electric lighting and to the cause of good illumination as a whole. We should, however, like it to be understood that the excellent precedent set by the B.C.G.A. of stating the claims of the illuminant it represents, without attacking rival illuminants, should be followed.

A really successful movement in the direction of popularising the use of gas or electric lighting should enlist the support both of supply companies and of the local contractors and dealers in lighting appliances. We believe that by the help of the platform of the Illuminating Engineering Society a spirit of co-operation, helpful alike to the supply company, the dealer in gas and electrical accessories, and the public, might be brought about. Already many instances can be mentioned of results that could hardly have been attained except by the aid of this platform. For example, through the existence of this machinery, the Report of the Home Office Departmental Committee on Lighting in Factories and Workshops has already received much attention and become widely known to manufacturers, and will have an enormous influence on the industrial lighting of the future. Special mention may be made of the constant references to this Report in the advertisements of the B.C.G.A.—an enterprising and judicious step that might equally well have been adopted in connection with electric lighting. There are many other directions in which the claims of good illumination could be brought home to public authorities and Government departments, if only those concerned with lighting of all descriptions would co-operate in the illuminating engineering movement, in a fuller and wider way.

We see clearly that there is a strong tendency in this direction. There are many cases where the local authority owns both the gas and electric supply, and many dealers throughout the country who work both with gas and electric lighting and require further education in their correct use and applications. In the future, we believe, gas and electric concerns will draw closer together. The possibilities of joint effort in this direction were foreshadowed by Dr. Carpenter at the meeting of the South Metropolitan Gas Company this month when he said :—

> " I do not know whether the policy adopted by Parliament, of putting suppliers of gas or gaseous and electric energy into competition, has not had its day ; it may have. If one were to begin again, one would not do what one is doing to-day, viz., put up a large station to produce electric energy and another for gaseous energy. We should look to see whether these supplies should be undertaken separately, or whether there was not a great deal to be said on the point of economical working for running them together."

At the present time our activity in many fields of illuminating engineering is restricted by war conditions. But when peace returns once more there will be unrivalled opportunities for pressing home the need for better illumination in the streets, schools, public buildings, &c., throughout the country. We hope that these possibilities will not be neglected by gas and electric supply authorities throughout the kingdom. Valuable pioneering work in this direction has already been done by the illuminating engineering movement, but greater encouragement is necessary if complete success is to be attained.

Education and Scientific Research.

In our last number we referred to the Report issued by the Consultative Committee on Scholarships for Higher Education, and mentioned some instances of schemes being promoted to foster scientific education and research in various parts of the world.

During the past month there have again been several announcements of interest. The new President of the Board of Education is Lord Crewe, who, in view of his relation to the Imperial College of Science, will doubtless lend a sympathetic ear to proposals for developing scientific and technical education. His speech in the recent discussion in the House of Lords, which covered broad ground, might doubtless be taken as an indication of the intentions of the Government.

The Prime Minister has appointed two new Committees (1) to inquire into the position occupied by Natural Science in the educational system of Great Britain, and to advise what measures are needed to promote the advancement of pure science and the interests of trades, industries, and professions depending upon Applied Science, and (2) to conduct a similar inquiry into the position occupied by the Study of Modern Languages.

Another item of interest is the issue of the Memorial by the British Science Guild, which contains a number of suggestions for securing to science a more adequate representation in the national educational programme and in Governmental affairs, special reference being made to the need for scientifically trained men in certain departments of the Civil Service.

Readers will also recall the conference called by the Royal Society some months ago to consider the formation of a Board of Scientific Societies, with a view to securing the co-operation of those interested in pure and applied science, promoting the application of science to industry, and discussing questions on which international co-operation seems advisable. According to a recent announcement the Board at present consists of representatives of twenty-seven scientific and technical societies. An executive committee has been appointed, consisting of Sir Joseph Thomson (Chairman), Dr. Dugald Clerk, Sir Robert Hadfield, Mr. A. D. Hall, Prof. Herbert Jackson (Hon. Secretary), Sir Alfred Keogh, Sir Ray Lankaster, Professor A. Schuster, Sir John Snell, Professor E. H. Starling, Lord Sydenham, and Mr. R. Threlfall. The first meeting of the Board was held on July 20th, and it is evident that the scheme is now assuming concrete form.

Naturally in the case of a scheme of this magnitude a good deal of preliminary discussion is needed, but it would be helpful if a fuller statement of the intentions of the Board and the proposed methods of enlisting the co-operation of scientific and technical societies throughout the country, could be made at an early date. There is doubtless a very considerable number of such societies anxious to participate in the scheme and awaiting further information; and, as many of them are already engaged in work which involves some degree of co-operation, publicity would be helpful in suggesting how such work could be co-ordinated with the programme of the Conjoint Board, and how possible overlapping of effort could be, so far as possible, avoided.

Problems in Phosphorescence and Luminescence.

On page 249 we make a few notes on a most interesting lecture on "Radium and other Luminous Compounds," delivered by Mr. F. Harison Glew before the Optical Society (London) last June.

To the illuminating engineer the principles involved in the behaviour of these self-luminous substances are of great scientific interest. The war has brought before us a number of special applications for these materials, and who can say what their possibilities may be in the future? The mysterious production of light by the firefly has often been referred to as an example of "cold light," and there have been attempts to isolate and prepare synthetically the substances from which the luminous effect appears to proceed. For many years, too, it has been known that certain sulphides would, after exposure to daylight, continue to emit light in the dark, and the writer has a very vivid recollection of some experiments in this direction shown him by Mr. W. J. Hammer during a visit to the United States in 1907. It appears that the excitation of this luminous effect is accomplished mainly through the presence of ultra-violet rays and, now that we have available sources of light which are relatively rich in this form of radiation, the study of these effects would be of great interest to lighting engineers. Chemists and physicists have carried out many researches in this field, but there still remain many problems which have not yet been properly investigated, and require for their solution the combined efforts of the chemist and the photometric expert.

Little has been published regarding the intensity and duration of the luminosity excited in these materials. When the paint has been exposed and removed to a dark chamber the initial brightness gradually diminishes. The efforts of experts will doubtless be concentrated on the problem of increasing the intensity and duration of this effect. The problem of producing paint which will retain its brightness, without the necessity for exposure to daylight, is of distinct practical importance. In order to secure a relatively "permanent" effect the sulphide material is mixed with a minute percentage of a radio-active substance, by which it is continually excited, thus giving a steady glow. In this form the paint has many applications for underground work, for outlining the figures on dials of watches and scientific instruments, and for other special purposes.

It appears that at present the surface-brightness of freshly prepared material may approach a value equivalent to 0.03 ft.-candles, which is approximately twice the luminosity of a white surface illuminated by strong moonlight. The rate at which this initial brightness diminishes seems to depend on many factors, such as the percentage of radio-active material combined with the luminescent sulphide.

If it were possible to produce the exciting element in much larger quantities, the high cost of this self-luminous material might be diminished, and this would naturally lead to a great extension in its practical applications. Radium is still an expensive article. A possible substitute mentioned by Mr. Glew is mesothorium, which, if capable of manufacture on a large scale, may prove of some value.

The whole subject is a most fascinating one, and deserves closer investigation in the immediate future.

LEON GASTER.

SOME PROBLEMS IN THE USE OF ELECTRIC INCANDESCENT LAMPS.

BY AN ENGINEERING CORRESPONDENT.

THE question of the rating of lamps has been recently much discussed in this journal, especially in connection with the variations in distribution of light from gas-filled lamps. There is a growing recognition that the only satisfactory basis of comparison is in terms of the total output of light—either mean spherical candlepower or lumens. It is not proposed to go over this matter again; but it is of interest to mention some striking figures published by R. C. Robinson*, in the United States. A comparison was made between four types of gas-filled lamps, having differently shaped filaments. The watts per mean horl. c.p. varied between 0·595 and 0·82, whereas the mean sph. c.p. per watt was substantially the same in each case. This shows that horizontal candlepower is not a satisfactory basis of measurement even for when comparing gas-filled lamps with one another—still less in when comparing gas-filled lamps with other illuminants.

LIFE AND EFFICIENCY.

Another fairly well established point is that the use of the term "half-watt" lamp is unsatisfactory. "Gas-filled" lamp is a better description.

While the higher candlepower units may operate at about 0·6 watts per candle (horizontal) the high voltage, low candlepower units, it is well known, do not work at this efficiency. Generally speaking, it seems best not to describe any type of lamp by a term indicating its efficiency, especially as, in view of the rapid progress being made in the improvement of such lamps, any such term may require revision later on.

At present but few impartial records of the life of such lamps have been published in this country. According to some curves given in an article by Pirani and Meyer* in Germany last year, the specific consumption, of 1000 watt 220 v. gas-filled lamps increased, in the course of 1,000 hours, from 0·55 to 0·7 watts per H.K. (approx. 0·6—0·77 watts per candle). In the case of the 60 watt 110 v. lamps the corresponding change was from 0·72—0·88 watts per H.K. (approx. 0·8 to 0·96 watts per candle). The initial lumens per watt were given as 14·0—22·8 for various types (roughly equivalent to a range of 0·6—1·0 watts per candle (mean spherical).

While these figures may be regarded representative of good lamps, in the case of inferior types less satisfactory results might doubtless be obtained. The difference between a good and poor lamp is probably even greater here than in the case of ordinary tungsten lamps The manufacture of the latter has become more or less standardised, and the general level of excellence is much higher than a few years ago. Gas-filled lamps, on the other hand, are still a novelty, and their manufacture is less stereotyped. Moreover, their performance is effected by a variety of factors. For example, G. S. Merrill† recently published some life-curves, illustrating the effect of the method of spacing the coils of the filament. In the gas-filled lamp a balance is struck between the increased temperature of the filament and the heat-losses conducted through the surrounding gas A change in the coil-spacing of the filament during life exposes a larger superficial area, thus diminishing the temperature of the filament. Presumably this might result in a longer actual life; but at the same time efficiency of the lamp might diminish by 10—15 per cent.

* Trans. Ill. Eng. Soc., U.S.A., November, 1916.

* Elektrotechnische Zeitschrift, Nos. 38 and 39, 1915.

† Trans. Ill. Eng. Soc., U.S.A., June, 1916.

WHEN SHOULD GAS-FILLED LAMPS BE USED?

This leads us to an important point for consumers. Under what conditions is it preferable to use gas-filled lamps rather than ordinary tungsten lamps? Many people have very hazy ideas on this point, and it would be a help if manufacturers who are concerned with both varieties of lamps would publish data in their catalogues, indicating roughly the circumstances in which each type of lamp is best. No one now doubts that there is an important field of usefulness for the gas-filled lamps of high candlepower. On the other hand, when the voltage is relatively high, the cost of current low, and the type of unit desired of small candlepower, their advantages of gas-filled lamps are at present less evident. The lamps are still relatively costly, and consumers cannot always be induced to keep an adequate stock in hand. The dissatisfaction caused by several failures without means of replacing them makes a deep impression, even though the consumer may himself be partly to blame in the matter. Irregularity of life is more troublesome than a life which, though relatively short, can always be relied upon.

From a series of comparisons recently carried out by the writer (taking into account cost both of energy and of replacing lamps), it appears that high candlepower gas-filled units (300 c.p. or over), will in general be more economical than ordinary tungsten lamps if the cost of energy is over 1½d.–2d. a unit. On the other hand, experience suggests that the small 100 watt high voltage units are at present usually less economical than the vacuum lamps, even if the cost per unit is in the neighbourhood of 3d. or 4d. a unit.

OTHER CIRCUMSTANCES AFFECTING PERFORMANCE OF GAS-FILLED LAMPS.

One meets great diversities in experience with gas-filled lamps, especially the smaller units. In some cases everything goes well; in others unexpected failures cause a lot of trouble. No doubt in some instances the irregular life may be attributed merely to bad luck in getting a poor batch of lamps (and consumers are apt to remember an unfortunate experience and forget the times when all goes well!).

But there are other suggested explanations which seem to deserve investigation. One factor is the regularity with which the lamps are used. The writer recalls a conversation with a railway engineer in the early days of metal filament lamps, in the course of which he was informed that the average life on this particular section of the line amounted to several thousand hours, while lives of even 7,000 hours were not unknown. In view of the opinion generally held at that time that metal filament lamps were not yet adapted to withstand the vibration of railways, this seemed remarkable. The explanation apparently lay in the fact that the lamps were kept burning almost continuously, and were rarely switched off. On the other hand, when a carriage was detached and left in the shed for a night, it was often found that quite a number of the lamps failed on switching on.

The tendency to fail when switched on, owing to the high initial current through the cold filament, was a characteristic of early tungsten filament lamps. It is possible that this temporary surge of current, which is accentuated in the gas-filled lamps, has an appreciable effect on their life, especially in the case of the finer filaments. According to the oscillographic records of Pirani and Meyer (*loc. cit.*) the initial current may be as much as 15 times the final value, and it may take 0·3 seconds before the steady value of the current is attained. A similar effect occurs on breaking, and the writer was recently informed by an engineer engaged in some experiments involving much making and breaking that special rotary quick break switches were found necessary. The switches previously used would break 8 amperes satisfactorily on an 8 ampere arc-light circuit, but would not answer on a 4½ amp. circuit containing gas-filled lamps.

It therefore seems advisable to limit the switching on and off of such circuits as far as possible. This is confirmed by the experience in certain works, where the lamps are kept running for day- and night-shifts, and are only rarely extin-

guished, and where excellent results as regards average life have been obtained. In munition works, which are running day and night, this is a point worth noting.

Another question which has been raised in connection with gas-filled lamps, and seems to deserve attention, is the effect on the life of lamps of enclosing them in globes or fittings with inadequate ventilation. Owing to the heat developed in these lamp fittings they require special design. Does the mere fact of enclosing a lamp in a globe or reflector, which may limit the radiation of heat, and appreciably affect the temperature of the lamp as a whole, affect its life? Statements to this effect have been made in regard to high candlepower tungsten lamps of the ordinary variety, and there is a general impression that the practice of covering lamps with coatings of lacquer, which has become usual since the outbreak of war in order to comply with the lighting regulations, materially shortens their life. Some years ago it was even suggested that changes in atmospheric temperature might have an appreciable effect on the candlepower of standard electric incandescent lamps, although the experiments of the writer and others failed to obtain confirmation in this case. But if, as seems possible, the enclosure of ordinary vacuum lamps has any influence on their life, one would expect this effect to be accentuated in the case of gas-filled lamps, the filaments of which are run at a higher temperature. The matter deserves scientific investigation. Should this suggestion be confirmed it would afford another reason for preferring well-constructed fittings which, besides improving the distribution of light, are specially designed with a view to affording adequate ventilation.

LAMPS ON ALTERNATING CURRENT.

The last point which the writer desires to raise is the effect on vision of such fluctuations in light as occur in lamps run on alternating circuits. It is well known that the cyclical variations in the light from arc lamps run on an alternating P.D. may be rendered quite evident. Whether or no they are perceptible to the eye, or have any fatiguing effect on it, when the observer is working with stationary materials, is doubtful. But if such a light is used to illuminate rotating machinery "stroboscopic" effects may be produced. Machinery which is in motion may appear stationary if the period of revolution coincides exactly with the cyclical variations in the light of the illumination. In certain circumstances the apparent direction of revolution may even be reversed, *e.g.*, the teeth of a lathe lighted by an alternating arc may appear to be moving backwards. Similarly quick motions of an implement in the hand of a workman produce a succession of moving images—which is naturally distracting. It is in fact generally recognised that alternating arcs are unsuitable for the illumination of processes involving rapid manipulation.

If an incandescent lamp is run on a circuit of low periodicity (as, for example, a frequency of 25), the variations in brightness are perceptible to the eye, and similar effects might be produced. The effect is naturally most pronounced with tungsten lamps of low candlepower, having thin filaments which cool and heat more readily.

But it has generally been assumed that in the case of an ordinary lighting circuit (with a frequency of 100 or 50), the effect is inappreciable. Experiments have shown that a flicker photometer cannot be conveniently used for testing an alternating arc owing to the production of stroboscopic bands; but no such effect could be detected on an ordinary lighting circuit with incandescent lamps. This is a fairly delicate test.

The question has been raised anew by E. A. Salt, in an article in the *British Journal of Photography*.* The author finds that a glow lamp fed from an alternating circuit is unsuitable for retouching work, and attributes this to the fluctuations in light. The existence of such fluctuations was demonstrated as follows.

A slit was illuminated by a 200 volt 20 watt incandescent tungsten lamp on an alterating circuit with a frequency of 50. An image of this slit was projected on to a photographic plate which was rotated during half a second, and subsequently de-

* Alternating Current and Eyestrain, *Brit. Journ. of Photography*, July 7, 1916.

veloped. If the lamp had given a steady light a band of uniform brilliancy would be expected. Instead of this a series of a hundred bright bands, corresponding with the reversals of the light, was obtained. A 55 watt 200 volt lamp gave a similar result.

This experiment shows the existence of cyclical variations in the light. It does not, as the author remarks, indicate the extent of the variation (which would be accentuated or diminished according to the exposure), nor does it in itself give any information as to its effect on vision. When one looks at such a lamp run on an ordinary A.C. lighting circuit the variations in light occur too quickly to be perceived by the eye. It is not quite clear whether the unsuitability of this light for retouching arose through the production of stroboscopic effects and moving images of the pencil, or whether, in the opinion of the experimenter, the light would have been equally trying even for the illumination of stationary objects.

The matter is one which ought to be cleared up. Common experience suggests that there can be no very marked disadvantage in the use of incandescent lamps on alternating circuits for ordinary work, but it is conceivable that in certain circumstances it might have drawbacks, for example, in very fine work, carried out over long intervals of time, with moving implements. Here a small, but appreciable stroboscopic effect might have a cumulative effect.

It is also possible that, even when no change in brightness can be detected by looking at the lamp, minute fluctuations in brightness might be perceived when the eye is directed on illuminated stationary objects. This would depend on many factors, such as the illumination used and the extent of the variations in light produced in the lamp. Experience with flicker photometers shows that, even with a brightness-variation of 20 per cent., flicker becomes inappreciable with a frequency of 30 per second.* It hardly seems likely that on an ordinary lighting circuit, with a frequency of 50 or 100, the variations in the brightness of illumination produced by an incandescent lamp would be perceptible.

There is also the further distinct question whether such cyclical variations, even though not directly revealed to the eye, either in the form of visible fluctuations or stroboscopic effects, may have a cumulative influence on vision.

Conceivably even those changes occur too rapidly to be recognised, they might have a fatiguing effect on the nerves controlling the eyes. From this broader aspect even the relatively small variations which occur on an electric direct circuit or gas supply deserve consideration. It is of course true that the variations in daylight are far greater than those met with by artificial light, but these natural fluctuations take place comparatively slowly and the eye can accommodate itself to them. Perhaps, in the smaller but more abrupt fluctuations that occur with artificial light, we have one explanation of the general acceptance of daylight as the best available form of illumination, and of the preference still often expressed for the steady mellow light of the oil lamp.

The whole question is essentially one for the physiologist to investigate. In the interests of illuminating engineering, it ought to be definitely settled.

* Trotter, "Illumination; its Distillation and Measurement," p. 180.

GERMAN ILLUMINATING ENGINEERING SOCIETY.

We notice that the next annual meeting of the German Illuminating Engineering Society has been announced to take place at Nuremberg on September 16th, Prof. Warburg presiding.

Among the papers to be discussed are :—"Technical Aspects of the Cathode Rays," by Dr. Norden; "The Limits of the Production of Light by Temperature Radiation, the so-called Mechanical Equivalent of Light, and the existing Incandescent Lamps," by Dr. Meyer; and "Factory Lighting," by N. A. Halbertsma.

RADIUM AND OTHER LUMINOUS COMPOUNDS*

To the lighting engineer phosphorescent and luminescent substances have always appeared a fascinating field for study. Several interesting investigations on this subject have been made in the United States from time to time, such as the analysis of the light from the fire-fly carried by Ives and Coblentz, and the researches on phosphorescence of Prof. Nichols of Cornell University. The light yielded by various phosphorescent insects varies much in colour, intensity and duration. Possibly in the future the chemist, by analysing the substances from which this light is derived, may eventually be in a position to produce synthetically a substance glowing brightly enough to have important practical applications.

In theatrical displays, the glow from various substances which phosphoresce after exposure to ultra violet light has already been utilised, and as we have now available sources of light which are very powerful in rays of this description the whole matter is worth study. Recently public attention has been drawn to the applications of such substances for various military purposes, for example in coating the dials of watches and instruments, star-maps, &c.

The recent lecture by Mr. F. Harrison Glew before the Optical Society was, therefore, very timely. The lecturer showed a number of striking experiments and gave much information on one section of the subject, the effects of radioactive substances on luminescing materials, of which little is generally known.

The phosphorescence of insects is apparently due to the oxidation of an organic fluid and fails under the head of "Chemi-luminescence." Some substances, such as quartz, sugar, fluorspar, &c., become luminescent when rubbed. This is termed "Tribo-luminescence." Again, there are certain crystals which after exposure to radium, will emit light under the action of heat ("Pyro-luminescence"). For example, a sample of spodumene, which had previously been placed in proximity to a large quantity of radium, becomes intensely luminous when heated, giving a beautiful orange glow.

The most familiar example of phosphorescence, however, is the behaviour of the so-called "luminous," or Balmain's paint. There are a number of substances, such as sulphide of zinc, which after exposure to light become themselves luminous, the brightness rapidly decaying, but remaining perceptible for hours. Mr. Glew showed how, by the rotation of cylinders coated with such substances (so that they are alternately exposed to the light from an arc and withdrawn), a very brilliant brightness, comparable with that produced by a 16 candle-power lamp at a distance of a few feet, could be produced; but this order of brightness is very transient. Nevertheless, the brightness still persisting after several hours may be sufficient to have some utility, and zinc sulphide and other substances have already found practical applications in this form. Zinc sulphide produces a greenish light, but by using other materials, blue, yellow, and even red light can be obtained, and spectacular luminous pictures of landscapes, &c., produced.

The most important application of these substances, however, is the form of the so-called "self-luminous" or permanently luminous paints. These do not need to be exposed to daylight or other appropriate illuminant in order to store up energy which is afterwards reproduced as a luminous glow, but give a continuous and steady light. This is accomplished by mixing the luminescing material with a minute proportion of radium bromide or its equivalent. Radium, like ultra-violet light, has the property of exciting luminosity in these substances, and, as it acts continuously, we get a permanent luminous effect. The initial brightness depends on the percentage of radioactive material mixed with the paint, and the rate of decay of this

* Notes on a Lecture delivered by Mr. F. Harrison Glew, before the Optical Society of London, June, 1916.

brightness depends on the initial value attained. (For example, the lecturer stated that two samples, prepared respectively with 0.4 and 0.2 milligrams of rad. bromide, had arrived at equality of brightness after eight months' use; thus the weaker preparation, though yielding originally the feebler light, has the longest life.)

The lecturer also touched on other possible stimulants for luminous paints, such as meso-thorium.

An interesting point is the method of measuring the brightness of luminous paints. The low luminosity (radium paint prepared to the Admiralty specification has a surface-brightness, when new, of 0.03 ft.-candles) and peculiar colour present difficulties, but for purely comparative work the latter difficulty can be overcome by viewing the surfaces whose brightness is compared through a gelatine of a yellow-green tint.

THE PROJECTING LANTERN.

By J. B. TAYLOR.*

A recent paper on the above subject, read by J. B. Taylor before the American Illuminating Engineering Society, summarises the fundamental principles of optical projection. Many expert operators hold the view that a more powerful light is needed to illuminate a picture 40 ft. away from a lantern, than when the screen is only 20 ft. away. Actually, if the picture is the same size, there should be no difference, as the same flux of light is used in both cases.

If, however, a larger picture is obtained in one case than the other, the brightness is naturally correspondingly reduced. The author discusses the intensity of brightness needed for lantern slides. From data obtained in this country and published previously in this journal, it appeared that one foot-candle in the whites was ample. This is confirmed by Mr. Taylor's statement that even ½ foot-candle has been used with satisfaction, although on occasions operators may use a brightness ten times as high. Another interesting point is the use of special semi-polished and translucent screens, which depart widely from Lambert's law. By such methods a much greater brightness can be obtained for a given flux of light in the case of those immediately facing the picture; but to those at the sides the picture appears relatively dark, so that it is only in exceptional cases that such screens can be conveniently used.

As regards the lighting of the theatre Mr. Taylor lays stress on the avoidance of bright points of light (indicating exits, &c.), which distract attention from the picture, and on the need for allowing time for the adaptation of the eye to the dark surroundings before a film is commenced.

In the discussion of this paper H. Gage referred to a very complete and perfect type of instrument which could be adapted for the projection of lantern slides, cinematograph films, and microscopic solid objects (on the epidiascope principle). For microscopic projection great flexibility is needed as it is frequently necessary first to show a subject as a general view and then portions of it on a larger scale. In the case of opaque projection only about 3 per cent. of the diffusely reflected light will go through a large-sized objective. This speaker also mentioned the following figures for the desirable brightness of the screen:—

	Ft.-candles.
In a dark room—	
Lantern slides ..	2.5
Microscope specimens	1
Moving pictures ..	3
In a room lighted from back—	
(0.7 ft.-candles general illumination) ..	6

Mr. M. Luckiesh remarked that the two chief causes of eye-strain in cinema work are unduly severe contrast between the brightness of the screen and the surroundings, and the flicker of the film. A moderate general illumination is desirable, although this will necessitate a somewhat higher brightness of the screen. There also seems reason to suppose, from experiments in flicker photometry, that the point at which flicker becomes evident depends to some extent on the illumination of the screen. This point deserves further investigation.

* Trans. Ill. Eng. Soc. (U.S.A.), May, 1916.

BRITISH SCIENCE GUILD.

Memorandum on Proposed National Statutory Board of Science and Industry.

An important memorandum on the above subject has just been issued by the British Science Guild, which has received the signature of many eminent men connected with science and industry. It is pointed out that "the present European crisis affords a unique opportunity of impressing upon all who are engaged in the executive functions of government, as well as upon those who are concerned with industry and commerce, the paramount importance of scientific method and research in national affairs."

After dwelling on the great advance in national prosperity brought about by the practical applications of science, and on the need for further encouragement of scientific investigation by the State, the memorandum presents a series of seven recommendations, which may be summarised as follows :—

(i) The formation of a National Statutory Board of Science and Industry, the permanent staff of which should consist mainly of persons of wide scientific knowledge and business experience. The functions of this Board would include the promotion of co-operation between manufacturers and laboratories for research ; the co-ordination of scientific effort through joint scientific committees ; the collection and publication of scientific and technical information ; the institution of a number of paid advisory committees consisting of men of wide scientific knowledge, assisted by expert investigators and technologists, who should receive reasonable fees for their services ; the mobilisation of the scientific industrial and educational activities of the nation so as to ensure ready response to national needs and emergencies.

(ii) In all departments of State in which scientific work is carried on, adequate provision should be made for the periodical and wide distribution of leaflets and reports, so that increased public interest and attention may be encouraged in the results.

(iii) Every industrial undertaking subsidised or otherwise assisted by the State should have upon its Board of Directors men who possess expert scientific knowledge of the business in which they are engaged.

(iv) Adequate remuneration and improved prospects should be offered by the Government, by Municipal Corporations, and by manufacturers to men who have received an effective scientific training. Means should be found of compensating and rewarding persons whose researches have proved of decided national or public advantage without being profitable to themselves.

(v) A knowledge of science should be regarded as an essential qualification for future appointments in the departments of the public service concerned with industrial, scientific, and technical developments. A committee, on the lines recommended by the Royal Commission on the Civil Service in 1914, should be appointed to consider the present syllabus of subjects for examination for clerkships, and science should be adequately represented upon it.

(vi) Measures should be taken to revise the educational courses now followed in the public schools and the Universities of Oxford and Cambridge.

(vii) In elementary and secondary schools supervised by the Board of Education, more attention should be given to scientific method, observation and experiment, and to educational handwork.

RESEARCH UNDER THE BIRMINGHAM GAS DEPARTMENT.

AN interesting departure by the laboratory of the Birmingham Gas Department is reported. For some years special researches have been conducted in connection with the applications of gas, but it is now proposed to widen the scope of these inquiries in order to include other experiments of general value to manufacturers. Captain Hilton, the secretary and manager of the Birmingham City Gas Department has been approached on this matter by organised bodies of local manufacturers, and it is proposed to extend the activities of the laboratory by engaging the services of a staff of experts having adequate theoretical training and a knowledge of the applications of science in specific industries.

The laboratory will conduct researches of general utility by which manufacturers as a whole may benefit, and will also carry out confidential investigations for individual manufacturers.

CO-OPERATION BETWEEN THE GAS COMPANY AND THE ARCHITECT.

AN article by D. Knickerbocker, a consulting architect of Philadelphia, read at the mid-year conference of the National Commercial Gas Association in the United States,* makes some suggestions as to opportunities for co-operation between gas companies and architects, on whom the lighting and heating arrangements of many buildings depend.

He lays stress on the value of bulletins giving prompt and practical information of novelties in gas heating and lighting, and containing such particulars as an architect would naturally require, and points out the need for standardisation of procedure in piping buildings. Practical information on hot-water supply is particularly needful to the architect.

In electric lighting his work is simplified by the National Electrical Code, adopted by the leading electrical companies and professional societies throughout the United States; this is invariably required by the Board of Underwriters, without whose certificate the fire insurance companies will not issue policies of insurance. The architect, therefore, inserts in his specification a clause requiring work to be done in accordance with the National Electrical Code.

In gas lighting, however, there is no such generally accepted code, and architects commonly employ general wording to the effect that "the best quality must be used," or "the work carried out to the satisfaction of the architect," &c. This leaves room for misunderstanding in view of the varied practice of local gas companies in different States. "A National Basic Code with a piping schedule of minimum standards for sizes, lengths and weights would therefore be of the greatest advantage. . . ." A schedule has already been formulated by the B.C.G.A., and would form a nucleus of a final code if taken up and formally adopted, with suitable modifications by the American Gas Institute, the American Institute of Architects and other interested bodies.

Such a standard Schedule would then be adopted throughout the United States. At present some local authorities and gas companies have adopted excellent rules. In Philadelphia, for example, the ordinance authorising the United Gas Improvement Co. to lease the Philadelphia Gas Works, requires the company to exercise supervision over the work and material used and specifies the exact rules to be complied with.

But the adoption of a general series of rules applicable everywhere would smooth away many difficulties and would be helpful in securing an improvement of conditions in many localities where old-fashioned and unsatisfactory methods of piping are still in force.

* *Intercolonial Gas Journal of Canada*, Aug. 1916.

A YEAR'S PROGRESS IN ILLUMINATING ENGINEERING.

A Report presented by the Committee on Progress (Mr. F. E. Cady, *Chairman*, Mr. T. J. Litle, Mr. L. B. Marks, Mr. T. W. Rolph), at the Ninth Annual Convention of the Illuminating Engineering Society, held in Washington, September 20th to 23rd, 1915; slightly abbreviated.

(*Concluded from Vol. VIX., July* 1916, *p.* 230.)

Reflection.—Now that semi-indirect and totally indirect lighting systems are coming more and more into use, the effect of the walls and ceilings in reflecting light is of great importance. The results of considerable work on tests of the reflecting power of paints have been presented. The[145] colours examined ranged from white to dark buffs and greens. The highest coefficient obtained was 0.657 which was for a white oil paint of medium gloss. Less than one-half of the samples tested showed coefficients above 50 per cent. and all of those that did so were of very light creamy or yellowish tones. A rather light olive colour gave only 0.328.

Code.—Reference should be made to the very important work of the Committee on Lighting Legislation and the Factory Lighting Committee of this society, as a result of which a code on the lighting of factories, mills and work-places has been prepared.

Globes, Reflectors and Fixtures.

Having plenty of light available either from gas or electricity manufacturers have increased the variety of materials used in making globes, reflectors and shades. At one extreme might be put the wicker basket, which provided with or without a lining is used suspended from the ceiling as a semi-indirect fixture, or inverted and covered with suitable material, it makes a shade for a table lamp. At the other extreme might be put the hammered brass bowl with or without glass inserts and used either for totally indirect or semi-indirect lighting. There is a growing use of floor lamps having very large shades and mounted on standards 5 or 6 ft. (1.52 or 1.82 m.) high. Such a lamp is replacing the old centre table lamp for family reading and inasmuch as those using it can all have the light properly directed for reading purposes, it forms a step in the direction of eye protection. There is also a growing trend on the[146] part of architects to call for lighting fixtures which conform to the period of their surroundings.

In schoolrooms an increasing tendency toward the use of denser glassware with the semi-indirect lighting method is noticeable and in general for both direct and semi-indirect system the denser glassware is used. Furthermore the tendency towards constantly increasing candlepower in small units has led to a greater use of diffusing media such as marble and alabaster, and to fixtures carrying several lights burning upright with small semi-indirect shades. The use of cloth for shades is growing and an umbrella manufacturer has developed[147] a collapsible shade of cretonne, which can be folded up, when not in use, for packing or storage purposes.

A novel arrangement has been brought out in England[148] for converting a dining room fixture into a combined direct and semi-indirect unit. A double cone of white silk is employed in conjunction with the common "corona band" so that the lamp occupies a position in the lower cone, when the fitting is at the usual height, giving light directly downward, while at another height the lamp moves up into the upper cone, with the light directed toward the ceiling.

For the modern very large office building an equipment of specially designed fixtures is not uncommon. In

145 *Elec. World*, Jan. 23, 1915, p. 211.

146 *Elec. World*, Apr. 3, 1915, p. 871.

147 *Light. Jour. and Eng.* (Lond.), Feb., 1915, p. 81.

148 *Ill. Eng.* (Lond.), Mar., 1915, p. 103.

one case of this kind[149] a fixture was developed which can be utilized either for direct, semi-indirect or totally indirect lighting. There is evidence[150] of a considerable increase in the employment of the semi-indirect type of fixtures for gas.

A great advance has been made in gas fittings.[151] The old "goose neck," fastened with a wire, is being replaced by straight pipe tubing with gas-tight adjustable couplings, which make a variety of brackets available.

Reflectors have been developed for converting[152] the ordinary gas arc as used in stores and warehouses into a semi-indirect unit, thus meeting the demand for this type of lighting without the necessity of scrapping former fixtures. The advent of the 100-watt, gas-filled tungsten unit has caused the development of prismatic and mirrored reflectors for use in show-window lighting.

In lighting fixtures of ornate design and equipped with electric candle or candelabra lamps the use of ordinary key or pull sockets for individual lamp control is often undesirable and esthetically objectionable. A rotating switch has been devised to meet[153] this condition, which is operated by turning an outer sleeve forming part of the candle. The replacing of arc lamps by the new high efficiency tungsten lamps has resulted in an[154] adaptation of the fixtures of the former to act as housings for the latter. The principal change needed is the introduction of baffle plates to prevent the entrance of rain without hindering the ventilation. For all classes of outdoor lighting by electricity fixtures have been designed which include[155] not only adaptability to series or multiple circuits, to pole or cross-span suspension, but also ventilating and enclosing glass ware if desired, so that a complete equipment is available in one fixture.

A reinforced-concrete lighting standard of attractive design and appearance is being installed[156] in a number of California cities including beach resorts, where metal standards have suffered severely in the past owing to the action of salt air.

149 *Elec. World*, Feb. 20, 1915, p. 490.
150 *The Gas Age*, Jan. 1, 1915, p. 8.
151 *Light. Jour.* (U.S.), Dec., 1914, p. 281. *Proc. Amer. Gas Inst.*, vol. IX, 1914, p. 886.
152 *Amer. Gas Lt. Jour.*, May 3, 1915, p. 286.
153 *Elec. Rev. and W. E.*, May 29, 1915, p. 1005.
154 *Elec. World*, May 1, 1915, p. 1131.
155 *Elec. Rev. and W. E.*, July 24, 1915, p. 167.

Photometry.

The measurement of light sources differing in colour value continues to interest the photometrist. Developments have followed two general lines, one the elimination of the colour difference, thereby reducing conditions to those of ordinary photometry, the other the use of the flicker photometer which has not yet been generally accepted as a solution of the problem.

Secondary Standards.—At the National Physical Laboratory in England there has been completed and described[157] a careful and exhaustive research having for its object the establishment of a set of standards matching in colour lamps operating at the various efficiencies in ordinary use. In this research the colour problem was met by using the so-called "Cascade" method in which a lamp at a given watts per candle is measured against one whose watts per candle differs by an amount which will make the colour difference small enough not to be objectionable. Check measurements were also made in which the maximum colour difference was encountered. The experience gained from these and other comparisons was that whereas an observer may be relied upon for constancy of judgment in measuring with an ordinary contrast photometer sources differing by a small amount in colour value, the same constancy in judgment was not obtainable where the colour differences were large. Efforts were made to use the flicker photometer but the results were not satisfactory and the accuracy was of a different order of magnitude from that found with the other method.

Colour Difference.—It is rather interesting to note that elsewhere[158] in observations on colour differences made with a flicker photometer and extending over a year, individual observers reproduced their results with very few exceptions.

156 *Elec. World*, Apr. 3, 1915, p. 874.
157 *Phil. Mag.*, July, 1915, p. 63.
158 TRANS. I. E. S., Apr. 30, 1915, p. 207.

The colour screen method of eliminating the colour difference in heterchromatic photometry has been extended by the development[159] of a blue solution, which in varying degrees of saturation will provide a colour match between a standard carbon lamp and another lamp operating at any watts per candle from 3·1 to 0·5. An alternative for[160] the colour absorbing solution in eliminating colour differences is suggested in a new photometer using polarised light. It is based on the rotation of the plane of polarisation by a quartz plate and the fact that this rotation is different for light of different wave-lengths.

Flicker.—By applying to a modified form of the Conroy photometer[161] an oscillating platinised mirror and adding an optical wedge having its density gradient vertical and different by two per cent. from top to bottom a new flicker-photometer has been developed. Another arrangement[162] for a flicker-photometer consists in a modification applicable to the ordinary Lummer-Brodhun photometer head. A tube, replacing the ordinary eye-piece, carries a rotating prism. Means are provided for illuminating the surrounding field and for accurate speed control.

A theory of the flicker-photometer has been presented in[163] which the behaviour of the instrument is deduced directly from the relationship of critical frequency and illumination. It is assumed that a fluctuating stimulus is transmitted as a considerably dampened fluctuating impression whose form and amplitude can be calculated by using the Fourier linear diffusion equation. The same line of reasoning is used to explain the relationship of colour flicker to brightness flicker. Further work[164] has also been done on the question whether results in colour photometry obtained by the flicker method and the acuteness of vision method are the same. The data obtained in these experiments indicated they are. A Lummer-Pringsheim spectro-flicker-photometer was employed and experiments made with foveal vision and portions of the retina lying 20° to 30° outside the direct line of sight. Means have been provided,[165] using coloured absorbing media for correcting an abnormal eye. It is claimed that by the practical application of this method to the flicker-photometer it is possible to equip any observer so that he will read correctly colour differences of a given type; and to equip a colour-blind observer so that he will not only read such differences correctly, but also measure other colour differences with no more uncertainty than a random observer of "normal" vision will do.

Integrating Sphere.—At the last convention there was quite a discussion on the best paint to use for the inner diffusing surface of an integrating sphere. An elaborate research was undertaken in Germany[166] to decide not only this point but also the best material of which to make the sphere itself. The results indicated that iron plate is to be preferred to zinc for the construction material and that zinc white as the diffusing surface gives the best results.

New Instruments.—In the photometry of phosphorescent gases and certain phosphorescent solids, the light to be measured is of rapidly diminishing intensity. In order to ascertain the errors occurring in the measurement of such a light a modification of the ordinary photometer has been devised[167] in which the essential feature is a sliding carriage supporting one of the lamps and capable of being set in to and fro motion at uniform velocity in the photometric axis. Means are provided for recording the position of the carriage while in motion. Using this instrument an investigation showed that errors as high as 15 per cent. or more and apparently due to retinal fatigue, may occur in the photometric of phosphorescent decays.

A new portable illumination photometer has been brought out[168] which is a modification of the Weber type and much more compact. Another illuminometer[169] has been described for use

159 TRANS. I. E. S., Apr. 30, 1915, p. 253.
160 *Phys. Rev.*, July, 1915, p. 64.
161 *Phys. Rev.*, 4, 1914, p. 477.
162 *Light. Jour.*, May, 1915, p. 111.
163 *Phil. Mag.*, May 28, 1915, p. 708.
164 *Ann. d. Phys.*, Aug. 14, 1914, p. 105.
165 TRANS. I. E. S., Apr. 30, 1915, p. 259.
166 *Elek. Zeit.*, Mar. 25, 1915, p. 37.
167 *Phys. Rev.*, Oct., 1914, p. 289.
168 *Elec. World*, Jan. 9, 1915, p. 85.
169 *Elec. World*, Jan. 16, 1915, p. 170.

where rapid and rough measurements of light intensity are desired. In this instrument a screen of black silk illuminated from the rear is viewed in comparison with tinted sectors, on which falls the illumination to be measured. The intensity of the light from the comparison lamp is controlled by an iris diaphragm. As a quick means of determining the various energy relations in tungsten lamps, a direct reading instrument has been devised[170] using data presented at the last convention.[171] It is made up of volts, watts per candle and per cent. candlepower scales. The volt scale has a range from 94 to 166 volts, while the watts-per-candle scale limits are 0·70 and 2·05. Knowing any two relations the other may be calculated within the range of the instrument.

A study[172] of the rotating sectored disk when used in photographic photometry has shown that an intermittent exposure, such as that given by the disk, has the same integral effect as a continuous exposure for the same period. The conclusion for ultra-violet radiation is the same as that found for visible radiation. Experiments were made on a variety of plates and it was found that the results were independent, within wide limits of the rate of rotation of the sector and of the period of exposure.

Gas-filled Tungsten Lamps. — The measurement of the candlepower of the gas-filled tungsten lamps has developed some entirely new problems in photometry. Thus it was early discovered[173] that both the watts consumed and the candlepower of the lamp vary when the lamp is rotated at different speeds. One set of experiments[174] showed that for any change in speed, while the change in candlepower was roughly ten times the change in current but always in the opposite direction, and regardless of the position of the lamp, the absolute change in candlepower with the lamp in the position of tip up is about twice the change with the tip down and similarly for the absolute change in the current. From the photometric standpoint a favourable condition was discovered in that for a given position of the lamp, the current and therefore the candlepower return to the stationary value at the same speed. If then, a gas-filled lamp is photometered in the position tip down, while rotating at the particular speed which gives the same current value as when the lamp is stationary the mean horizontal candlepower as measured will be free from errors due to rotation.

Various explanations have been offered for these phenomena. It has been suggested that they may be due to variations in the contacts between the filaments and the anchor wires; to changes in the currents of gas about the filament; to the lengthening of the helically coiled[175] filament, thus changing its resistance; to a cooling effect due to the action of the external air in the bulb.

Photo-electric Cell.—In astronomical photometry[176] work is being done with some success, looking toward increasing the sensibility of the photo-electric cell. A null method of using photo-electric cells has been devised, which,[177] it is claimed, does away with the so-called "dark current" without in the least reducing the sensitivity.

Pentane Standard.—A redetermination at the National Physical Laboratory[178] of the constants of the Pentane lamp gave the following as the equation of the candlepower:

$$\text{C.P.} = (\,(1+0.0063\,(8-e)-0.0008_5\,(760-b)$$

e being the humidity in litres of water vapour per cubic metre of moist air, and b the barometric pressure in millimetres. Evidence was obtained that there exists a temperature coefficient in the case of the pentane lamp, a point which had been raised previously at the Bureau of Standards. Apparently the temperature and humidity effects act against one another and in practice it is the difference between the two which is operative. It is suggested that if work of the very highest accuracy is to be carried out with flame standards under abnormal humidity conditions, the combined humidity temperature coefficient

[170] *Jour. of Frank. Inst.*, July, 1915, p. 102.
[171] TRANS. I. E. S., 9, 1914, p. 734.
[172] *Ann. d. Phys.*, Nov. 3, 1914, p. 801.
[173] TRANS. I. E. S., 9, 1914, p. 1024.
[174] *Elec. World*, Dec. 26, 1914, p. 1248.
[175] *Elec. World*, Jan. 9, 1915, p. 78.
[176] *Science*, June 4, 1915, p. 810.
[177] *Phys. Rev.*, July, 1915, p. 66.
[178] *Phil. Mag.*, July, 1915, p. 80.

should be determined for the locality in which the work is to be conducted.

Radiation.—Experiments[179] on the emissivity of metals at high temperatures have given results indicating a change in the emissivity of platinum for wavelength $\lambda=0{\cdot}65\mu$. This fact if verified would influence the constancy of the Violle standard of light.

Two investigations have been made during the year on the determination of the visibility of radiant energy. One covered[180] the whole visible spectrum going further into the red and violet than heretofore. The other[181] dealt with the red end of the spectrum only, results being obtained out as far as $\lambda=0{\cdot}770\mu$.

Calculation.—Methods of calculating the illumination produced by a direct-lighting source are numerous and well known. But in the case of a totally indirect or semi-indirect unit the calculation is decidedly modified. A method has been proposed[182] in which it is necessary to know only the photometric curve, the coefficient of reflection for the secondary source (usually the ceiling), the distance of the unit below the ceiling and the height of the ceiling above the plane of illumination. Roughly the method involves the consideration of the ceiling as a secondary light source considered as made up of a series of circular annuli or rings of uniform intensity of illumination. The effect of each ring is calculated independently.

Nomenclature.—Considerable attention has been given to the subject of nomenclature during the past year. It has been proposed[183] that the word "lambert" be used in referring to brightness in lumens per unit projected area. The "lambert" is interpreted as the equivalent in appearance to the eye of a surface source emitting one lumen per unit area in accordance with Lambert's cosine law. The following resolution which was submitted by the Committee on Nomenclature and Standards has been approved[184] by the Council of the Society:

Resolved, That it is the opinion of this Committee

(*a*) That the output of all illuminants should be expressed in lumens.

(*b*) That illuminants should be rated upon a lumen basis instead of a candlepower basis.

(*c*) That the specific output of electric lamps should be stated in lumens per watt and the specific output of illuminants dependent upon combustion should be stated in lumens per British thermal unit per hour.

Photography.

Sources.—The use of gas light[185] for taking pictures is increasing and special mantles have been designed for the purpose. In order to facilitate the use of the high intensity gas-filled tungsten lamp[186] in photographic portrait studios, a coloured glass screen has been developed which reduces the luminous intensity of the light to one-third its ordinary value without appreciably reducing the actinic value for ordinary plates. For convenience this glass has been incorporated in the lamp bulb. Thus high candlepower lamps may be used without producing an uncomfortable glare. It has been found possible[187] to use such lamps, screened as described, in moving picture production studios. In a big western moving picture plant[188] there is used a combination of mercury-vapour lamps and 2,000-candlepower tungsten gas-filled units of the type just mentioned. In Germany[189] tests have been made on the use of the gas-filled tungsten lamp for photographic work at voltages higher than normal, thus giving greater actinic value. This same idea has been proposed and experimented on[190] in this country.

Tests have been made on[191] the density of the photographic image produced under fixed conditions of distance and time by the light from different types of arc lamps

179 *Phys. Rev.*, Dec., 1914, p. 547.
180 *Phil. Mag.*, Feb., 1915, p. 301.
181 *Phys. Rev.*, July, 1915, p. 68.
182 *Elec. World*, June 5, 1915, p. 1463.
183 *Elec. World*, Mar. 29, 1915, p. 715.
184 TRANS. I. E. S., 9, p. 2, 1914.

185 *Gas Age*, Mar. 15, 1915, p. 304.
Light. Jour. (U.S.), Dec., 1915, p. 281.
Proc. Amer. Gas Inst., vol. 9, 1914, p. 886.
186 *Elec. World*, Nov. 14, 1914, p. 950.
187 TRANS. I. E. S., No. 2, 1915, p. 166.
188 *Elec. World*, July 17, 1915, p. 137.
189 *Zeit. f. Beleu.*, Mar., 1915, p. 33.
190 *Elec. World*, Nov. 14, 1914, p. 950.
191 *Elec. World*, Nov. 14, 1914, p. 956.

under various conditions. The lamps tested were of the alternating current and direct current enclosed carbon and flaming arc types operated at various currents. The results showed that the highest actinic efficiency was obtained by the 220-volt, enclosed carbon arc; next in value were respectively, the alternating current and direct current 110-volt, flaming arcs with electrodes designed particularly for photographic work.

A photographic paper has been developed[192] on which portraits may be reproduced directly without the preparation of the usual negative. For operation with artificial illuminants the paper is treated with a dye which makes it more sensitive to yellow light. The pictures are mirror images of the original.

Legislation.

Calorific Standard.—The Illinois Commission hac ruled[193] that in all parts of the state excepting Chicago a calorific standard of 565 B. t. u. for gas shall be used. Chicago is to remain under the candlepower standard. The calorific standard has been adopted by the Maryland Public Service Commission.[194] A heating value of 600 B. t. u. is specified. It was estimated by the Commission that in the state generally only 6 to 10 per cent. of the gas used is burned in flat flame burners. The use of the calorific standard in gas undertakings does not seem to be growing rapidly in England.[195] Only eight companies have applied for Parliamentary authority during the session of 1915. Four of these companies applied for a 500 B. t. u. standard.

Glare.—Extremely bright lamps are no longer allowed on residential streets, especially in front of isolated stores, in Washington, D.C.[196] Regulations adopted prohibit the use of lamps exceeding 100 candlepower on streets other than business streets. They also require a minimum height of 15 ft. (4·57 m.) for all private lamps supported from sidewalks, and that such lamps are to be enclosed in opalescent globes in order that the eyes of passers-by shall be protected from glare.

In December last[197] the War Department issued regulations ordering all fishing fields to be protected by a marine lantern of recent invention using acetylene as the illuminant. These lanterns, capable of 23 days' service, are arranged to give an in-shore and out-shore light to warn vessels that the areas thereabout comprise fishing pounds and are not open to navigation. Already a number of these lights have been placed.

A bill has been introduced[198] in the Utah legislature providing for the creation of special lighting improvement districts, under which the property owners on any street or sub-division may petition the city commission to create such districts and to install therein lighting systems.

Safety.—The Ottawa (Canada) City Council have recently[199] taken up the matter of all-night lighting of public buildings used for residence purposes. A by-law has been passed providing that the stairs, halls and corridors of all apartment houses, hotel and lodging houses must be lighted up from sunset to sunrise.

In places where public safety demands it there is a growing tendency on the part of municipal authorities to require two independent systems of illumination so that in cases of failures on the part of either the other will be available.

Headlights.—The Public Service Commission of Vermont has issued an order[200] concerning the use of headlights on locomotives. Railroad corporations doing business within the state are required to equip engines with headlights of not less than 2,500 apparent beam candlepower when measured with the aid of a reflector, rated in accordance with the average of the centre readings between 500 and 1,000 ft. (304·80 m.) ahead and upon a reference plane 3 ft. (0·91 m.) above the rails. In Nevada an amendment to the electric headlight law has been passed,[201] providing that any electric headlight " which

---

192 *Elec. World*, Jan. 16, 1915, p. 190.
193 *Proc. Amer. Gas Inst.*, vol. 9, 1914, p. 373.
194 *Jour. of Gas Light.*, May 24, 1915, p. 463.
195 *Amer. Gas Light Jour.*, Feb. 1, 1915,p. 73.
196 *Elec. World*, Oct. 10, 1914, p. 700.
197 *Acet. Jour.*, Feb., 1915, p. 305.
198 *Elec. Rev. and W. E.*, Feb. 27, 1915, p. 376.
199 *Elec. News* (Can.), Apr. 1, 1915, p. 38.
200 *Railway Age Gazette*, Jan. 22, 1915, p. 127.
201 *Railway Age Gazette*, Jan. 22, 1915, p. 123.

will pick up and distinguish an object the size of a man dressed in dark clothing on a dark and clear night at 1,000 ft." will be deemed equivalent to a 1,500-candle-power headlight measured without reflector. Legislation regarding head-lights for motor vehicles has also been passed in New Jersey.

Illuminating Engineering in General.

Daylight Saving.—By adopting eastern standard time Cleveland, Ohio, has added one hour to the period of daylight. The result[202] has caused a renewed interest in the so-called "daylight saving movement" in the middle west. In Holland also this movement is being agitated.[203]

The use of light sources imitating daylight is growing[204] and has been found advantageous not only in clothing, painting and wall paper stores and factories, but also in printing and lithographing establishments, paper mills, oil refining plants, cigar factories, &c.

It has been proposed[205] to add to the numerous collections in Berlin a museum of illuminating appliances in which the development from the 17th century of lamps and other devices for street lighting will be shown.

Luminous Efficiency.—Values of the radiant luminous efficiencies (ratio of the energy radiated evaluated according to its effectiveness in producing the sensation of light to the total energy radiated) of various light sources have been determined using the method which employs an absorbing solution whose transmission curve is the same as the luminosity curve of the eye.[206] Among the results obtained were :—

4 w.p.c. carbon lamp	0.43
0.8-ampere Nernst filament ..	1.08
6.6-ampere gas-filled tungsten at 0.65 w.p.c.	2.93
Ordinary vacuum tungsten at 1 w.pc.	1.99
Open burner, gas	0.9
Incandescent mantle, gas	0.5 to 1.2
1.7 ampere mercury arc, Pfund type	30.0

A new experimental determination[207] by two different methods gives for the mechanical equivalent of light a mean value of 0·00162 watt per lumen.

Physiology.—Further work has been done on[208] the effect on the eye of ultra-violet light. It has been shown that where the protein in the lens of the eye has been modified by the action of excess sugar in the body fluids, or by the action of salts of calcium, magnesium, silica and the like, ultra-violet radiation may cause cataract, but that unless this abnormal condition exists cataract is not caused by this form of radiation.

Music and Colour.—Several attempts to correlate music and colour have been made in the past. A Russian composer having written a score in which was included a part to be rendered by various colours ; a "colour organ" was devised for use in a recent presentation of the composition.[209] Incandescent lamps in reflectors and equipped with colour-filters formed the light source. The screen was composed of strips of gauze of various weights mounted vertically 8 by 10 ft. (2·43 by 3·04 m.) in size. The lightest sheet was placed at the front, each succeeding one back of it being heavier. The rear gauze was heavy enough to reflect the light thrown on it. The deepest colours were thrown on the back and the lighter colours were thrown on the front gauzes. The colour equivalents of the tone scale were as follows : C, red ; D, yellow ; E, pearly blue ; A, green ; B-flat, steely gray ; together with intermediate values. Colour organs are not new,[210] several having been constructed in recent years. The largest screen used has been 30 by 50 ft. (9·14 by 15·24 m.).

International Commission.—At the meeting of the National Illumination Committee of Great Britain held early in the year[211] there was considered the question of "Rating of Light Sources in Candlepower or Consumption," and the following resolution was passed and transmitted to the Secretary of the

202 *Elec. Word*, Jan. 2, 1915, p. 59.
203 *Jour. Gas Light.*, Jan. 5, 1915, p. 16.
204 *Elec. Word*, July 10, 1915, p. 71.
205 *Jour. Gas Light.*, May 4, 1915, p. 292.
206 *Phys. Rev.*, Mar., 1915, p. 208.
207 *Phys. Rev.*, Apr., 1915, p. 269.
208 *Elec. World*, Apr. 19, 1915, p. 912.
209 *Sci. Amer. Supp.*, June 26, 1915, p. 408.
210 *Sci. Amer.*, July 24, 1915, p. 79.
211 *Jour. Gas Light.*, Feb. 9, 1915, p. 326.

International Commission on Illumination.

It is desirable that a uniform international method be adopted for rating and marking all sources of light. It is recommended by the National Illuminating Committee of Great Britain that the matter be considered at the next session of the International Commission on Illumination; and the administration of that Commission is asked t o take the necessary steps to bring this resolution to the knowledge of the different national committees, with the view to their co-operation.

Literature.

The war has seriously interfered with many foreign publications having articles on illumination. The French Journal, *Science et Art de l'Eclairage*, has apparently suspended publication and other French and German journals were compelled to omit some issues although they are now appearing regularly. Among the books published during the year should be mentioned :—

Modern Illuminants and Illuminating Engineering, by L. Gaster and J. S. Dow. New York, The MacMillan Co., 1915.

La Lumiere Electrique et ses DifferentesApplications du Theatre, by V. Trundelle. Paris, H. Dunod and E. Pinat.

An Introduction to Colour Vision, by Dr. J. H. Parsons. Cambridge University Press, 1915.

ILLUMINATION OF TROLLEY-WIRES.

AN interesting example of the special problems in street-lighting occasioned by the present conditions is to be seen on the tramway at those points in London where there is a transition from the slot to the trolley-wire system. The driver in such cases has to unfasten the trolley pole and connect with the line overhead. On nights when there is a moon, and the pole and wire can be seen silhouetted against the sky, there is little difficulty. But on dark nights, with the present diminished artificial illumination, the process became distinctly awkward. The wire cannot be clearly seen, and passengers would have to endure a period of constant flickering while the pole scraped the wire, missed, and hit it again.

The difficulty is now got over by the use of a flat dish-reflector containing a lamp and attached to the supporting lines above the live wire. The illuminated surface of this reflector affords the necessary bright background, and is so constructed that no direct rays can be seen from above.

NATIONAL PHYSICAL LABORATORY.

REPORT FOR YEAR 1915—1916.

The Report of the National Physical Laboratory for the year 1915—1916 has now appeared.

As might have been expected, the ordinary work of the Laboratory has been largely set aside in favour of special researches undertaken for Government Departments. For example in the section of optics, the staff have been engaged in the testing of binoculars, telescopes and other optical "munitions of war," and special researches have been made on the intensity and duration of light yielded from luminous paints Very important work has also been conducted in the department of aeronautics.

We are glad to see that the generosity of private benefactors has to a great extent made good the deficit in fees ordinarily received for industrial work, and hope that after the war the Laboratory will be placed in a position to carry on its valuable researches on a much more extensive scale.

AT a meeting of Liverpool business men at St. George's Hall, on Empire Day, organised by the British Electrical and Allied Manufacturers' Association and presided over by the Lord Mayor, the following resolution was passed :—

"That the indispensable military services rendered by the engineering industry and its fundamental importance in the future as the basis of defensive power and of prosperous economic development, entitle it to special State recognition in any reform of national and imperial commercial policy, and to the patriotic support of all public and private users of plant and machinery throughout the Empire."

THE LIGHTING OF ARMY HUTS.

We recently heard of a large camp of Army huts, which were being lighted by gas, and where the question of the best method of illumination was under discussion. Hitherto the huts have been lighted in the ordinary way by incandescent units, but the hard usage to which the lamps have been subjected makes the question of maintenance rather troublesome. For example, the men are apt to throw their caps and other missiles about, occasionally striking the lamps—treatment which even the best of mantles, unless specially protected, will resent.

It has therefore been suggested that flat flame burners should be used. This seems a retrograde step, especially in view of the probable diminution in the illuminating power of the gas, just now owing to the withdrawal of constituents wanted for munition work. A preferable step would probably be to substitute mantles enclosed in "binnacle-lights," which are mounted direct on the wall and are capable of withstanding any reasonable amount of shock. The introduction of these units would involve some initial expense, but would doubtless be justified by the results as regards illumination and maintenance.

A similar problem arises in connection with the use of electric incandescent lamps. While large mess-tents, etc., where the lights are quite out of reach, may be illuminated by pendant units, it would seem desirable to avoid pendants altogether in the smaller rooms and to mount the lamps direct on the ceiling. A simple form of metal reflector is also useful, both as a protection and with a view to concentrating the light downwards. In this case also there seems an opening for a cheap type of completely enclosed unit, similar to those used on board ship.

REFINEMENTS IN ILLUMINATION.

In a recent article in the *Electrical Review* it is remarked that there are still endless opportunities for ingenuity in meeting special problems and opening new fields of lighting.

As an instance reference is made to the lighting of pulpits in churches. It is generally recognised that the lamp should be screened and that the direct rays should on no account be allowed to stray into the eyes of the congregation. The design of the most convenient form of reading lamp, at a convenient height to illuminate the desk evenly and yet not to obstruct the congregation's view of the preacher, is, however, worth attention. In addition, it is questionable whether such shaded lights should throw light on the book only, leaving the preacher's face in shadow. A congregation likes to see the face of the preacher. A special case is presented in churches ministering to the deaf, and the same problem recurs in all buildings where training of the deaf is carried on. In such cases the preacher's meaning is interpreted by observing the motions of the lips and the face generally, and the facility with which this can be done depends very much on the provision of an adequate illumination. Indeed, people who are only slightly deaf, or even people who have normal hearing, really derive appreciable assistance from the observation of the face of the person with whom they are conversing.

Another special opportunity for skill in illumination is to be found in art museum-lighting. The possibilities of special units, both for displaying exhibits and as a decorative element in themselves, have hardly been explored as yet. For example, the problem of artificially illuminating precious and perishable articles in showcases, so as to show off their outline and colour to the best advantage, and also to preserve them as far as possible from colour-depreciation through the action of the short waves of light, is well worth study.

CORRESPONDENCE.

"CELL-PHOTOMETERS."

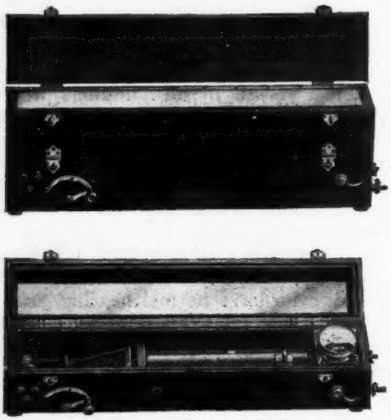
To the Editor of the ILLUMINATING ENGINEER.

DEAR SIR,

I have read in the March issue of the ILLUMINATING ENGINEER the very interesting descriptions of the "cell type" and "graded scale type" photometers by Mr. Cunnington and Mr. Dow.

It occurs to me to mention that photometers on the same principle were constructed by Mr. Kovalen, chief engineer to one of the electric supply stations in Petrograd, about the year 1906.

In this instrument he employed an opal glass screen illuminated from below



General view of Kovalen's Box Photometer (enabling illumination to be determined by inspection without manipulation of parts).

by a low voltage (4.5 v.) lamp, fed from a storage battery. This screen formed the cover of a long black box, the lamp being mounted at one end, on the bottom of the box. The upper surface of the glass screen is painted dead white but there is a narrow slit left in the middle, which runs the full length of the screen. This screen is covered by a thin plate of ground glass, which carries an appropriate scale.

When the lamp is switched on we see at one end of the screen a dark slot with white surroundings, and at the other end the converse effect, the point of balance, indicating the illumination, being intermediate. There is no difficulty in ascertaining the point of balance and reading off the corresponding value in lux. The range of this instrument is normally 0.2—60 lux but it can be extended if desired. The box carries a rheostat and a voltmeter reading up to 6 v. and also an adjustable glass screen for diminishing the illumination of the slit and thus extending the range of the instrument, if required.

The general nature of the instrument is shown in the accompanying photographs. The precision of measurement is naturally not so high as in the case of apparatus of a more elaborate type, but the convenience of being able to make a rapid estimate of the illumination on a large surface is very useful for some classes of work.

Yours, &c., S. MAISEL
(Physical Laboratory, Institute of Mines, Petrograd).

A POCKET LAMP WITHOUT BATTERY.

The *Elektrotechnische Zeitschrift* (Feb. 24th) describes a novel form of pocket lamp that has been devised by K. v. Dreger of Budapest. This contains a small glowlamp which is fed, not by accumulators or dry cells, but by a small hand-operated dynamo. The novelty of the arrangement appears to consist mainly in the ingenuity of the mechanism by which this is driven. If the lamp is held in one hand a slight motion of the thumb suffices to keep the dynamo in motion, and it is stated that even after the latter is removed the dynamo will continue to revolve long enough to give a light for several minutes.

THE PHOTOMETRY OF GAS-FILLED LAMPS.*

The photometry of gas-filled lamps presents quite a number of special difficulties.

On account of the comparative broadness of the filament spiral and the dissymmetry of the filament mounting there is considerable irregularity in the distribution of the light about the vertical axis. Consequently when the lamp is rotated the light as seen in the photometer appears to flicker so much as to render accurate photometry impossible. This difficulty may be largely eliminated by using two inclined mirrors behind the lamp.

There is, however, a more serious difficulty, namely, that rotation alters the current consumed and the resultant candlepower. The change in efficiency may be either positive or negative according to the speed of rotation, and there appears to be one particular speed at which correct results may be obtained; this speed is practically the same for all lamps having the same number of loops in the filament. If this precaution in selecting the correct speed is not observed, errors of 1 to 2 per cent. in current and 15—20 per cent. in candlepower may be encountered. Hence the voltage found for a desired operating efficiency may be so much in error as to give a lamp on test at this rated voltage a fictitious life three or four times as long as the lamp would give if operated stationary. The lamp may thus be given credit for a much longer life than it really deserves. On the other hand, the speed may be such as to cause errors in the opposite direction.

These changes during rotation appear to be due to alterations in the convection currents of the gas, with a consequent variation in temperature distribution within the bulb.

Another point to be noted is that the blackening of a gas-filled lamp does not occur uniformly over the bulb as is the case with a vacuum lamp, but chiefly at the top of the bulb. Hence in making a life test, a true measure of the reduction in total light during the life of the lamp can only be determined by measurement of the total flux or mean spherical candlepower. This is most conveniently determined in the Ulbricht globe.

* *Photometry of the Gas-filled Lamp*, by G. W. Middlekauff and J. O. Skogland (Bull. Bureau of Standards, Washington, No. 264, March 16, 1916.)

A NEW ILLUMINATION-INDICATOR REQUIRING NO MANIPULATION.

We notice that the type of instrument described in Mr. Maisel's letter in this issue (p. 262) is being developed in the United States. Such an instrument has been described by Mr. R. F. Pierce.* In this apparatus, which reads from 0·1 to 50 ft.-candles, there is also a slot along which the point of balance moves according to the illumination, but readings are facilitated by a series of disc-apertures at intervals, and the range is extended by using a second slot equipped with an interior dark covering reducing the brightness to 1/10th.

The simplicity of this type of instrument is a recommendation in cases where only rough indications of the illumination are needed; but one point, mentioned by Mr. Pierce, requires attention, namely, that the indication varies somewhat according to the angle from which the surface is viewed. A small sighting arrangement is therefore provided to secure that the angle of vision is always the same.

PROGRESS OF THE BRITISH RARE-EARTH INDUSTRY.

A paper on this subject was presented by Mr. S. Y. Johnstone at the Annual Meeting of the Society of Chemical Industry, held in Edinburgh last July. It was computed that the number of mantles used in the United Kingdom during a normal year is about 100,000,000, which would correspond with an annual consumption of 650 tons of Travancore monozite sand. In the past this country has had to depend very largely on imported mantles, and although manufacturers have developed their output very rapidly since the outbreak of war, there is evidently still a great deal to be done before they will be able to supply the entire needs of the country.

* *Am. Gaslight Journal*, Aug. 14, 1916.

TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

SOUTH METROPOLITAN GAS CO. Half-Yearly General Meeting.

At the half-yearly general meeting of the South Metropolitan Gas Company on August 9th an interesting address was given by the Chairman (Mr. Charles Carpenter, D.Sc.), who explained the circumstances that had enabled the company to reduce the price of gas by 2d. per 1,000 cub. ft. An encouraging fact was the maintenance of the consumption of gas at slightly above the figure at which it stood previous to the war. There had been considerable diminutions in the amount of gas used for certain purposes, *e.g.*, for domestic uses and shop lighting, but, on the other hand, there had been an increased industrial demand.

Turning to the question of residual products and their paramount importance for war, the Chairman remarked that in future matters would have to be so organised that these essential materials could be obtained from the gas companies at short notice. The coal resources of the country would be dealt with in a less wasteful manner, the ammonia, light oil, benzol, etc., being removed, and the gas companies would probably be much larger suppliers of solid fuel than had hitherto been the case.

In this connection the Chairman made an interesting remark regarding the future co-operation of gas and electrical supply "I do not know," he said, "whether the policy adopted by Parliament of putting the suppliers of gas and electric energy into competition, has not had its day; it may have. If one were to begin again, one would not do what one is doing to-day, viz., put up a large station to produce electric energy and another for gaseous energy. We should look to see whether these supplies should be undertaken separately or whether there was not a great deal to be said on the point of economical working by running them together."

HOLOPHANE INDUSTRIAL LIGHTING UNITS.

We understand that a new edition is to be issued shortly of the booklet describing the Holophane units for Industrial Lighting. In these units the external surfaces of the prisms are completely protected against any possible deposits of dust and dirt by a coating of aluminium, and at the same time the reflecting value of the prisms is fully maintained. We are informed that these units are being extensively introduced into munition factories, but at the present time it is naturally impossible to say much on this matter.

The convenient tables given in the booklet, showing the illumination derived from units hung at any prescribed height, are retained in the new edition, but several modifications are made rendering them better adapted to practical use. Other features are the introduction of a series of units of the well-known Bowl and Excellite types for providing diffused semi-indirect lighting in offices and some simple iron fittings which are applicable both to office and industrial lighting.

THE "LISTER-BRUSTON" AUTOMATIC ELECTRIC LIGHTING AND POWER SYSTEM.

ELECTRIC lighting for country houses has passed through some interesting series of stages of development. The coming of the metal filament lamp proved a great godsend, diminishing the capacity of plant required for a given number of lights and furnishing a much more efficient illuminant than the old carbon filament lamp. A difficulty, however, has always been the necessity of providing a battery of accumulators, the upkeep and maintenance of which is often not fully understood or sufficiently appreciated by the consumer.

An interesting method of dealing with this problem is furnished by the Lister-Bruston system of lighting, which is essentially automatic. The current is supplied by a dynamo driven by a small petrol-engine, but only a few accumulators (of a specially strong type) sufficient to feed three or four lamps, are used.

If only a few lights are in use, the current is supplied by the accumulators. When, however, more lights are turned on, the extra current operates an automatic switch, causing the current from the cells to be delivered to the dynamo which rotates for a few seconds as an electric motor, thus starting the engine. From this point onwards the main load is taken by the dynamo. When the number of the lights is diminished a converse operation takes place, the dynamo and engine being automatically taken out of circuit as soon as only a few lamps are connected, leaving these supplied by the accumulators. The great advantage of this system is that the number of cells required is small and the loss involved in the charging and discharging of a battery sufficient to supply the entire lighting load is avoided. Moreover, as there are only a few cells of a robust type to look after, the expenses of maintenance are reduced to a minimum; in addition, the cells are automatically kept charged by the action of the dynamo, thus working under satisfactory conditions.

In the case of large installations, or for the lighting of a group of houses or a village, the plant is preferably subdivided. It can be so arranged that a light load starts up only one of the units, others being automatically switched into circuit as the load increases; and, conversely, cut out of circuit again as fewer lights are required. In this way the plant is always operated at a good efficiency.

As an instance of such an installation we may mention the recent lighting of the town of Seward, Albany, U.S.A., for the Seward Lighting and Power Co. We understand that the equipment, which consists of two Lister-Bruston Town Lighting sets complete, with a 300-ampere-hour battery, is worked entirely automatically, each of the sets starting and stopping as and when the external load demands. The total output of the station is about 20 k.w.

The speed with which this installation was carried out appears remarkable, the franchise being obtained, power-house built, mains run in streets, and the plant in full operation within six weeks.

We are also glad to note that the question of the best use of the lighting provided is not overlooked, and that the staff of Messrs. R. A. Lister and Co., 47, Victoria Street, London, S.W., are prepared to give advice as to the best schemes of lighting for buildings of all kinds.

REVIEWS OF BOOKS.

Colour and its Applications, by M. Luckiesh. (*Constable and Co., London,* 1915. 357 *pp.* 129 *illustrations,* 4 *colour plates.*)

MR. LUCKIESH'S work on colour is well known to readers of this journal, and his collection of the ideas that have recently been developed on this subject makes a most readable book. Probably the work will be chiefly useful to those who have kept in touch with illuminating engineering work during the last few years, but even those who have little expert knowledge of colour will appreciate his lucid treatment of this fascinating but highly complicated subject.

The initial chapters deal with fundamental principles. The author explains briefly the conception of light as a form of radiation, and traces the physiological factors involved in the subjective translation of this radiation into the impressions of light and colour. The distribution of energy throughout the spectra of the chief illuminants is illustrated by appropriate diagrams, the luminosity curves for the human eye at high and low illuminations are reproduced, and photographs of typical spectra are presented. The chapter on colour-mixture is illustrated by a coloured diagram showing the difference between additive and subtractive methods. The author comments on the need for some generally accepted method of colour definition, making effective use of a quotation from a letter from Robert Louis Stevenson bearing on this point. The chapter on the analysis of colour contains a series of diagrams of modern spectroscopes and spectrophotometers and the discussion on colour and vision is thoroughly up to date.

Of special interest are the tests carried out by the German Lighthouse Board of Hamburg on the visibility of signal lights. The agreement of these results with the more recent experiments of Paterson and Dudding at Teddington appears remarkably good, and formulæ connecting candle-power and range are suggested. The latter are, however, complicated by questions of colour. Reference is also made to the value of monochromatic light in enhancing acuteness of vision, and to the presumed advantages of using yellow light from which the blue and violet rays are excluded for searchlights. Yellow and fluorescent glass screens have been proposed for this purpose with a view to avoiding the "luminous blue haze" and improving definition.

Chapters are devoted to colour photometry and colour photography, and there is also a brief account of theories of colour vision.

The final section of the book, dealing with colour in lighting, contains much interesting matter. The author summarises the various attempts that have been made to secure "artificial daylight" for colour-matching work. The effect of different illuminants on the appearance of colours is illustrated by several coloured plates contrasting the appearance of pictures by natural and artificial light. This point is further explained by means of black and white reproductions showing how, by using light of a special colour, certain features in a picture may be made to disappear. This effect has been utilised in practice in illuminated signs, wherein certain words and phrases may be made to vanish by an alteration in the quality of the illumination. In a less marked degree these effects manifest themselves in many interiors, in which varied coloured wallpapers, borders and designs are employed.

Mention should next be made of Mr. Luckiesh's treatment of the subject of "mobile colour" as utilised in various devices for stage illumination. Here there are many as yet imperfectly explored possibilities. The idea of using colour-harmonies as alternative or supplementary to musical sounds is exemplified in the Rimington colour-organ, and in the devices employed by the composer Scriabine, who added to his orchestral score an accompaniment in which colour changes were specified as an accessory to the music. The mere fact that phrases descriptive of colour occur so frequently in musical criticism shows the existence of such an analogy, and it is conceivable that in the art of the future colour harmonies will play a more important role than at present.

The author's practice of recording a complete list of references at the end of each chapter will be a recommendation to those who have not yet gone deeply into this subject. A word of commendation should also be given to the excellent printing, mat paper without glaze being used throughout both for the text and the illustrations.

A Statistical Report of Electric Undertakings in Japan (1914), *issued by the Direction General of Electric Exploitations, Department of Communications, Tokyo, Japan.*

A CORRESPONDENT in Japan sends us the above Statistical Report of electrical undertakings in that country, which, in view of the rapid industrial progress which Japan is now making, deserves careful study.

The first electrical undertaking was opened in Tokyo in 1887, one 75-h.p. dynamo being originally installed. Since then the various undertakings throughout the country have spread and developed, until to-day they produce millions of horse-power, a feature being the use of Japan's abundant water-power and of high tension transmission.

The Report is concluded by some interesting information covering the period 1903—1914. We notice that the total candlepower of lamps supplied has grown from approximately 4½ million to over 70 million during this period. Moreover, the rate of increase is still very rapid, being as much as 25 per cent. during the year 1914, while the extension of electric lines laid down for all purposes has taken place even more quickly.

The Development of Electric Lighting in Japan.

WE have received from the Tokyo Electric Co. a most interesting booklet tracing the development of electric lighting in Japan. Starting from the most primitive rush-lights, braziers and torches, illustrated by characteristically quaint Japanese prints, the book carries us through the stages of lighting by candles, oil lamps, and lanterns, &c., up to the illuminants of the present day. Many of the early designs of candle-sticks and lanterns are decidedly quaint or beautiful, and present a complete contrast with our highly utilitarian modern methods.

If one may judge from the illustrations, however, it would seem that electric lighting fittings are being adapted with little change from the designs usual in the West. While it cannot be doubted that in the East, as in the West, modern methods of illumination are inevitable and essential, yet one may venture to hope that the characteristic charm of the older illuminants will not be lost. Engineers and artists in Japan will, we hope, exercise their ingenuity in grafting the new on to the old, providing the higher standard of illumination entailed in modern progress, and yet preserving some of the quaint and picturesque simplicity of times gone by.

The Excess Profits Duty and Profits of Controlled Establishments, by E. A. Spicer and E. C. Pegler, Chartered Accountants. (*H. Foulks Lynch and Co.*, 61, *Watling Street, London.* 1916. 163 *pp.*)

AT the present moment there are few businesses which are not to some extent concerned with the Excess Profits Duty. While the principles involved are simple, the applications of the Excess Profits Duty to different classes of business are somewhat complex, and the above little volume should therefore be welcome.

The book is divided into five chapters, dealing respectively with the Excess Profits Duty, the Computation of Profits, the Pre-War Standard of Profits, Capital, and the Profits of Controlled Establishments. There are also an Appendix in which the section of the Act dealing with Excess Profits is reproduced, and a convenient Index. There is a concise summary of contents at the head of each chapter.

Paint and Colour Mixing, by A. S. Jennings. (E. and F. N. Spon, Ltd., London, S.W., 1915. 245 pp. Seventeen coloured plates.)

READERS of this journal are naturally interested in the question of colour, which is of importance in many lighting problems, especially in trades where accurate matching of shades is essential. This book, which summarises present practice in regard to paint and colour mixing, is therefore well worth study. The initial chapters contain an account of appliances for mixing and applying colours, and an explanation of the distinction between various oil and water paints, distempers, and special surfaces. There are also sections dealing with the chief colours in succession, and a feature is the series of coloured plates, containing, it is stated over 300 samples of actual oil- and water-paints and water-colours.

The chapter on nomenclature is of considerable interest. The author mentions several independent attempts to prepare a series of standard colours, for example, that due to Mr. Robert Ridgway, Curator of the Division of Birds, United States National Museum, Washington, and the excellent series of plates furnished in the "Repertoire de Couleurs par la Société Francaise des Chrysanthemistes." The systems of nomenclature adopted by those interested in different processes of colour-matching, *e.g.*, artists, flower florists, painters, dyers, &c., differ very considerably; even in the same trade surprising variations in the names assigned to colours seem to prevail. Evidently there is room for an attempt to frame a general scientific method of nomenclature.

Another matter is the matching of colours by various lights. The author refers to the need for using a good north daylight for accurate work, but he does not appear to deal with matching by artificial light in any detail. In a future edition it would be interesting to include some mention of the various forms of "artificial daylight" now available, and to discuss their practicability for colour-matching processes.

PERSONAL.

We are informed that Mr. S. R. Mullard, of the Research Laboratory of the Edison and Swan United Electric Light Co., Ltd., has been granted a temporary commission as Lieut. R.N.V.R., attached to the R.N.A.S. We understand that Lieut. Mullard is being retained by the Ediswan Co., which will enable him to keep in touch with his laboratory work.

We learn with great regret of the loss of Company-Sergeant Major E. C. Laughton, who for nine years was associated with the Lamp and Fittings Dept. of Messrs. Siemens Bros. Dynamo Works, Ltd., and was a member of the Illuminating Engineering Society. He joined the Forces in September, 1914, and fell during the recent offensive in France, after 14 months' active service. Besides showing considerable business aptitude, his genial disposition gained him many friends in the electrical industry, and his loss will be widely regretted.

Assets exceed £2,500,000.

Claims paid over £8,500,000.

By Appointment.

GENERAL

Accident Fire and Life

ASSURANCE CORPORATION, Ltd.

General Buildings, Perth, Scotland.
General Buildings, Aldwych, London.

Established 1885.

WAR ECONOMY.

In consequence of the War, the cost of building material and labour has increased nearly 50 per cent. All owners of property should therefore increase their Fire Insurances; this they can do at little or no extra cost by taking a Fire Bonus Policy with this Corporation, and thus effect a saving of 20 per cent. of each premium.

Particulars on receipt of post card at either of the above Offices.

F. NORIE-MILLER, J.P.
General Manager.

INDEX, August, 1916.

	PAGE
Architect and the Gas Company, Co-operation between	252
Army Huts, Lighting of	261
Birmingham Gas Dept., Research under the	252
British Science Guild, Memorandum of	251
Correspondence (Cell-Photometers). S. MAISEL	262
Editorial. L. GASTER	241
Illumination, Refinements in	261
Illuminating Engineering, A Year's Progress in (*concluded*)	253
Electric Incandescent Lamps, Some Notes on the Use of. AN ENGINEERING CORRESPONDENT	245
New "Illumination-Indicator," A. R. F. PIERCE	263
Pocket Lamp without Battery, A	262
Photometry of Gas-Filled Lamps. G. W. MIDDLEKAUFF and J. F. SKOGLAND	262
Projecting Lantern, The. J. B. TAYLOR	250
National Physical Laboratory, Annual Report	260
Radium and Other Luminous Compounds. F. HARRISON GLEW	249
Reviews of Books—	
Colour and its Applications. By M. LUCKIESH	266
A Statistical Report of Electrical Undertakings	267
The Development of Electric Lighting in Japan	267
The Excess Profits Duty and Profits of Controlled Establishments. By E. A. SPICER and E. C. PEGLER	267
Paint and Colour Mixing. By A. S. JENNINGS	268
Topical and Industrial Section—	
South Metropolitan Gas Co., Annual Meeting.	264
Holophane Industrial Lighting Units	264
The Lister-Bruston System of Automatic Electric Lighting	265
Insurance Coupon	269
An Industrial Indirect Lighting Installation. An Economic Night Light	270

COUPON INSURANCE TICKET

Applicable only within the United Kingdom.

GENERAL
ACCIDENT FIRE AND LIFE
ASSURANCE CORPORATION, LTD.,

Chief Offices—
GENERAL BUILDINGS, PERTH, SCOTLAND.
GENERAL BUILDINGS, ALDWYCH, LONDON, W.C.
F. NORIE-MILLER, J.P., General Manager,

To whom Notice of Claims under the following conditions must be sent within seven days of accident.

£250 TWO HUNDRED AND FIFTY POUNDS will be paid by the above Corporation to the legal personal representatives of any person who is killed by an accident causing material damage to the passenger train in which the deceased was travelling as a ticket bearing or paying passenger, or who shall have been fatally injured thereby, should death result within one calendar month after such accident. **Provided** that the person so killed or injured had upon his or her person, or had left at home this coupon, with his or her usual signature, written prior to the accident, in the space provided below, which, together with the giving of notice within seven days to the above Corporation is the essence of this contract.

This Insurance only applies to persons over 14 and under 65 years of age, is subject to the conditions stated above and contained in the General Accident Fire and Life Assurance Corporation Act, 1907, and holds good for the current month of issue only.

No person can recover under more than one Coupon Ticket in respect of the same risk.

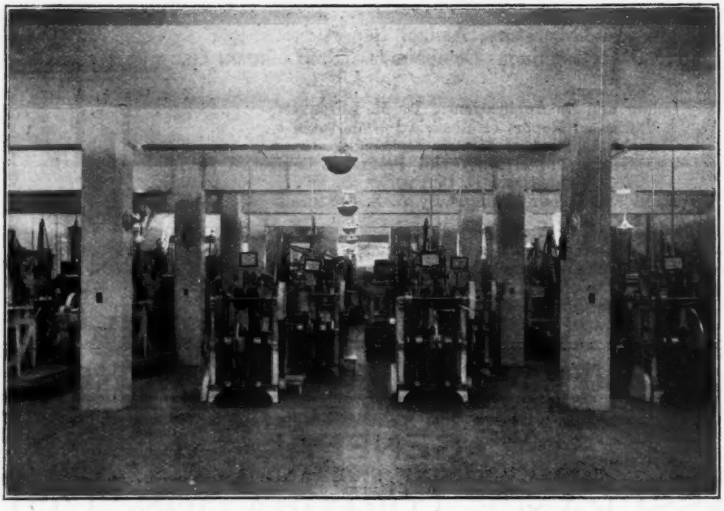
Signature .....

This Coupon must not be cut out but left intact in THE ILLUMINATING ENGINEER as that, being dated, forms the only evidence of its currency.

AN INDUSTRIAL INDIRECT LIGHTING INSTALLATION.

In view of the general impression that indirect lighting is somewhat limited in scope for industrial lighting, the accompanying illustration, for which we are indebted to the National X-Ray Reflector Co. of Chicago, is of interest.

The photograph refers to the Packing Dept. of one of the factories of the Kellogg Toasted Corn Flake Co. (Battle Creek, Michigan, U.S.A.), and is typical of the modern type of factory building now being constructed in the United States, for which reinforced concrete is largely used. The walls and ceilings are finished in white and the floors are of natural concrete. In these circumstances a considerable amount of diffused reflection is obtained, so that the conditions are favourable to indirect lighting.



The factory is divided into bays 13 ft. by 20 ft., making an area of 260 square feet for each bay. At the centre of each bay is suspended an indirect "X-ray" fitting with 300 watt lamp. The fixture is also finished in white and is washable.

The machines seen in the foreground fold the cardboard boxes in which the corn flakes are afterwards deposited. For such work well-diffused illumination is necessary and we understand that the indirect system has given satisfactory results.

We may mention that the British Thomson-Houston Co., Ltd., are sole British agents for all X-ray specialities.

AN ECONOMICAL NIGHT-LIGHT.

The need for low candlepower electrical units to serve as night-lights and for use in cellars, passages, &c., is well recognised. On D.C. circuits it is not very convenient to obtain a sufficiently low consumption unit, although various devices, such as the use of dimming switches, or of double filament lamps, have been used.

On alternating circuits the problem is easily solved by using a low candlepower metal filament lamp operated from a transformer. The "All-nite-lite" supplied by the British Thomson-Houston Co., Ltd., employs this method, a lamp giving 3—4 candles being mounted direct on a small transformer so that the whole can be conveniently inserted into a standard lamp socket. Where alternating current is available this little unit should be quite useful.